MARKED UP COPIES OF CLAIMS CHANGED BY THIS AMENDMENT

15 (amended) Apparatus ~~as defined in claim 14, wherein the refrigeration equipment or the like further includes an electrically powered defroster, and further characterized in that the selected group of operating parameters also comprises the defroster current~~ for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, a refrigeration chamber and an electrically powered defroster; said monitoring apparatus in operation periodically sensing the values of a selected group of operating parameters of the equipment, providing output data representative of the sensed values, and performing a series of equipment performance checks or tests on the output data thereby to identify existing or incipient problems with the equipment; characterized in that the monitoring apparatus is provided with sensors and sensed parameter data value inputs obtained from the sensors associated with the selected group of operating parameters, and that the said selected operating parameters include at least the following parameters:

(a) the line voltage of the source of electricity;

(b) the current drawn by the compressor;

(c) the condenser pressure;

(d) the refrigeration chamber temperature;

(e) the evaporator pressure; and

(f) the defroster current.

19 (amended) Apparatus ~~as defined in claim 18, wherein the refrigeration equipment or the like further includes an electrically powered defroster, and further characterized in that the selected group of operating parameters also comprises the defroster current, and that the selected performance checks include checks of the defroster current to reveal an existing or incipient fault condition that the defroster current is too high or too low, as compared with predetermined defroster current high and low threshold values~~ for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, a refrigeration chamber and an electrically powered defroster; said monitoring apparatus in operation periodically sensing the values of a selected group of operating parameters of the equipment, providing output data

representative of the sensed values, performing a series of equipment performance checks or tests on the output data thereby to identify existing or incipient problems with the equipment, and providing alerts or warnings for selected ones of the existing or incipient faults as (i) a high-alert signal if, for each such selected fault, the associated monitored parameter or parameters are of values that exceeds or falls below, as the case may be, a predetermined critical threshold as measured at a predetermined time or over a predetermined time interval thereby indicating that the fault condition is critical, and (ii) a low-warning signal if an existing or incipient fault condition is detected but the associated monitored parameter or parameters are of values that fail to cross the predetermined critical threshold; characterized in that the monitoring apparatus is provided with sensors and sensed parameter data value inputs obtained from the sensors associated with the selected group of operating parameters, and that the said selected operating parameters include at least the following parameters:

(a) the line voltage of the source of electricity;

(b) the current drawn by the compressor;

(c) the condenser pressure;

(d) the refrigeration chamber temperature;

(e) the evaporator pressure; and

(f) the defroster current

and that the selected performance checks include checks of the defroster current to reveal an existing or incipient fault condition that the defroster current is too high or too low, as compared with predetermined defroster current high and low threshold values.

24 (amended) Apparatus ~~as defined in claim 23, wherein the display monitor is or is incorporated into a pager~~ for monitoring refrigeration equipment or the like powered by electricity supplied by a suitable source, said refrigeration equipment or the like comprising an electrically powered compressor, an evaporator, and a refrigeration chamber; the monitoring apparatus comprising in combination, a sensor for continuously or continually sensing the value of each said parameter; a discrete signal collection unit connected to each said sensor for providing over time a stream of digital parameter data representative of a series of sensed values of the parameter with which such sensor is associated; a general-purpose computer for coordinating the operation of the sensors

and signal collection units and performing a series of performance checks on the equipment using the digital parameter data thereby to identify existing or incipient fault conditions in the equipment; data storage means for storing selected data; a communications link from each said signal collection unit to the computer for transmitting the data streams to the computer under the control of the computer; and a display monitor connected to and receiving output from the computer for viewing selected data and selected performance check results; characterized in that the data storage means includes reference data providing a standard of comparison against which sensed data may be compared; the computer compares the data stream or selected data extracted or calculated therefrom with the reference data or selected portions of the reference data when performing the performance checks; and the computer output to the display monitor and displayed on the display monitor includes the results of selected performance checks; wherein the display monitor is or is incorporated into a pager and is remote from the computer and is connected thereto by a telecommunications link.

REMARKS

(1) Reference is made to the following documents:

US patent 4,787,213 (Gras et al, Nov 29 1988)
US patent 3,555,251 (Shavit, Jan 12, 1971)

(2) The applicants cancel claims 1-14, 16-18 and 20-23 without comment.

(3) Further to the suggestions of the Examiner, claims 15, 19 and 24 have been rewritten in independent form. The amended claim 15 includes all the limitations of claim 14. The amended claim 19 includes all the limitations of claims 14 and 18. The amended claim 24 includes all the limitations of claims 22 and 23. Claim 25 requires no change as it inherits appropriate limitations from the now amended claim 24.

(4) Ten new claims are presented, 26-35. The last five are the apparatus counterparts of the method claims in the first five claims. The comments below regarding claims 26 to 30 apply *mutatis mutandis* to claims 31-35.

(5) The newly presented claim 26 addresses a fundamental aspect of the invention: digital parameter data are not just organized as time series data, but are stored in a database in that format and are used to produce two improvements in the way refrigeration equipment is monitored.

(6) The essence of the invention is to be found in the "Summary of the Invention" section of the specification (page 9, lines 15-18). In part this reads: "*a novel process is disclosed to obtain the values of selected parameters from associated sensors located on one or more refrigeration units, convert those values to digital form in standard units, and at regular intervals to record the digital data in a database*".

For example, Figure 8 shows a chart of the sensed values of five operating parameters [line voltage (822), compressor high pressure (824), compressor low pressure (826), refrigeration temperature (828) and compressor current (830)]. This is as described in the second paragraph (lines 8-21) on page 36.

The collection and storage of data in this way (as a time series for each of several parameters, recorded frequently) provides considerably more information than has previously been available. The preservation of data in this manner makes the newly submitted claim 26 novel, particularly with respect to the disclosure in Gras and Shavit.

In Gras, a number of sensors monitor temperatures producing digital signals as inputs for a program running on a computer [col 1, lines 54-60]. The program controls an expansion valve to affect the amount of cooling produced by the evaporator. Most of

the embodiments are directed to particular situations where specific control behaviour is required. Gras does disclose the output of signal values "in order to facilitate inspection or adjustment work" [col 4, lines 11-32]. However, at no place, does Gras disclose the collection and storage of a time series of values for the sensed parameters or the use of stored time series in equipment checks as is claimed by the applicants in claim 26.

Shavit discloses a control system for measuring the temperature conditioning load of a building and distributing this load in an optimally efficient manner to a number of power operated temperature conditioning apparatuses [col 1, lines 21-36]. The control method in Shavit relies on a set of temperatures and temperature differences measured at one point in time. There is no disclosure by Shavit of the collection and storage of a time series of values for the sensed parameters or the use of stored time series in equipment checks as is claimed by the applicants in claim 26.

(7) The resulting time series stored in a computer database make possible two improvements in the way refrigeration equipment is monitored. These improvements, taken individually or together, amount to a significant inventive step. The improvements are:

(a) New equipment checks are possible.

In the prior art, the checks are typically made by comparing levels. If the observed level of a parameter varies in a significant way from a threshold value, an alert is signalled. The threshold value is usually either supplied by the manufacturer of a component or by a technician, based on that technician's personal experience. The availability of a historical record makes possible significantly more useful analysis of the performance of refrigeration equipment.

For example, as equipment is used, it wears. Much equipment degrades before it fails. By simply observing the trend of an operating parameter, some problems can be detected early. For example, a properly lubricated rotor in a compressor should turn with little resistance on its bearings. The current drawn by the compressor motor is, in part, due to that required to overcome the friction in the rotor. If the friction in the bearings increases (perhaps due to loss of lubricant), this can be directly observed in the increased current drawn by the compressor. The failure of a compressor may be avoided by observing its current draw over a period of time. If the compressor current is seen to be steadily increasing, this may amount to an early warning of a problem. This may mean that the problem can be fixed by the replacement of a small, cheap part (such as a lubricant seal) rather than the replacement of a much more costly compressor pump.

The working example included in the specification (commencing at page 41) makes reference to "*very long almost continuous compressor on-cycles*" (page

44). The detection of such cycles in refrigeration equipment is only possible if sensed values are available as historical time series. It should be noted that the graph of Figure 19 shows data for 4 operating parameters recorded at one second intervals for 259200 seconds (72 hours).

The newly presented claim 27 specifically claims four equipment checks, disclosed in the specification, which require time series data. Neither the Gras or the Shavit reference discloses either the concept or specific examples of the improved equipment checks.

(b) More useful values may be obtained for threshold values.

Comparisons with threshold values are often not very helpful. To learn that the compressor amperage has exceeded the manufacturer's maximum rating means there is a crisis - the compressor will have to be turned off and a search begun for the cause. This information comes too late. What was needed was a system which could have reported that the compressor current draw has been steadily increasing from its normal behaviour.

The determination of the normal values and a description of their advantages ("learning mode") is included in the Summary of the Invention section of the specification at (5) on page 13 and in the Detailed Description of the Preferred Embodiment at (c) on page 32.

The newly presented claims 28-30 specifically claim the "learning mode" aspect of the invention and its application to specific equipment checks. Gras actually teaches away from the claimed "learning mode", opting instead for "reprogramming" [col 1, line 61] as the means to provide revised reference values. Shavit discloses means to update the stored data for each chiller at the end of each 20 minute period [col 3, lines 36-61] and the form of the data stored for each chiller is shown in Figure 2. It is important to observe that the updating of this data only makes use of values at one point in time. There is no disclosure of updating based on a stored historical record of equipment performance. Shavit does not suggest that such data be calculated from the recent history of the sensed values of the associated operating parameters.

Applicants respectfully submit that the pending claims 15, 19 ,24 and 25 are in condition for allowance and seek an early allowance thereof. Applicants suggest that the new claims are fully supported by the disclosure and are not anticipated by or obvious from the prior art and seek their early examination.

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David Wiebe
Inventor/applicant

Phillip Smith
Inventor/applicant

Lawrence Johnson
Inventor/applicant